

# Diseases of the Aorta

*ASE Review 2018*

Susan E Wiegers, MD, FASE, FACC  
Professor of Medicine

My great friend Dr. Roberto  
Lang

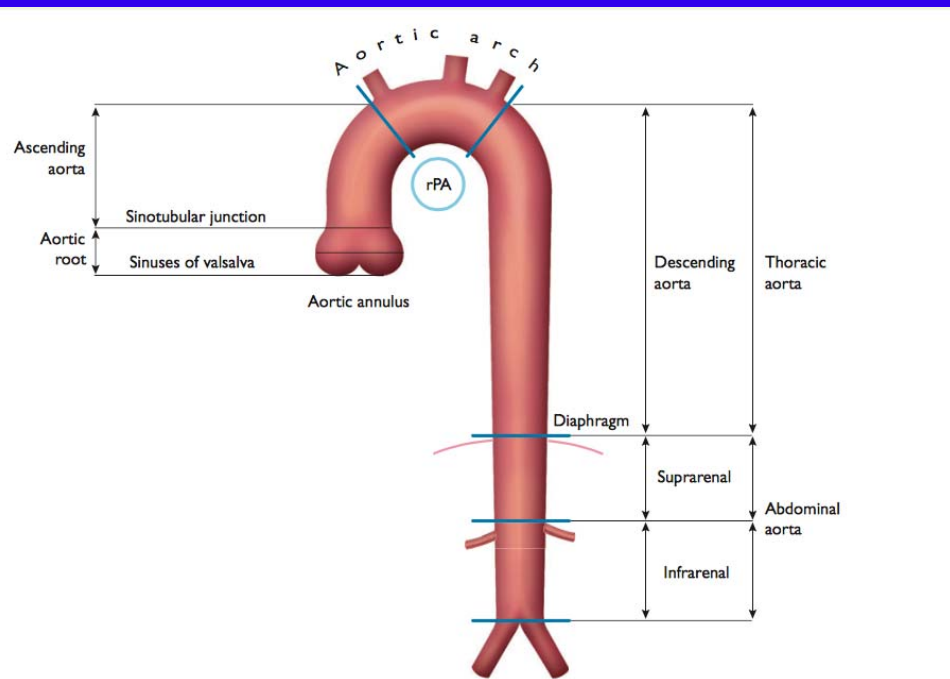
## Disclosure

None related to this presentation



## Objectives

- Aneurysm
- Dissection
- Intramural hematoma & ulcer
- Coarctation
- Trauma
- Atherosclerosis

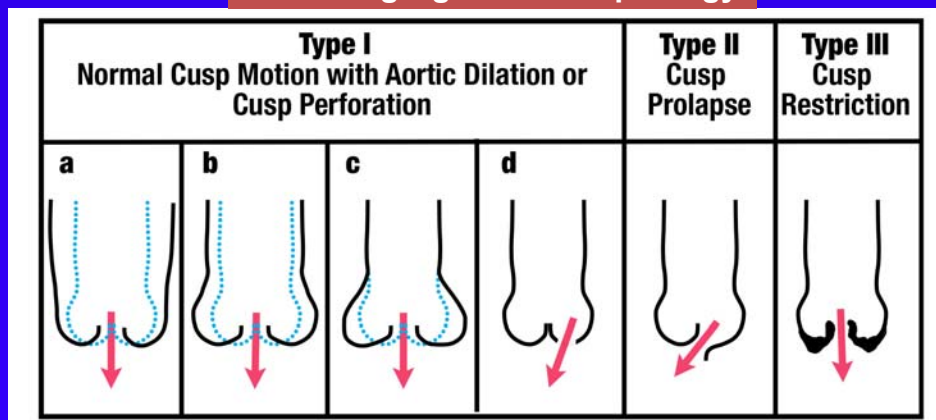


## Cardiovascular Ultrasound

- Don't forget to image the aorta
  - Parasternal long axis – ascending aorta view
  - Off axis 2 chamber – descending aorta view
  - Suprasternal notch – short axis and long axis
  - Subcostal view – include assessment of aorta



### Aortic Regurgitation Morphology



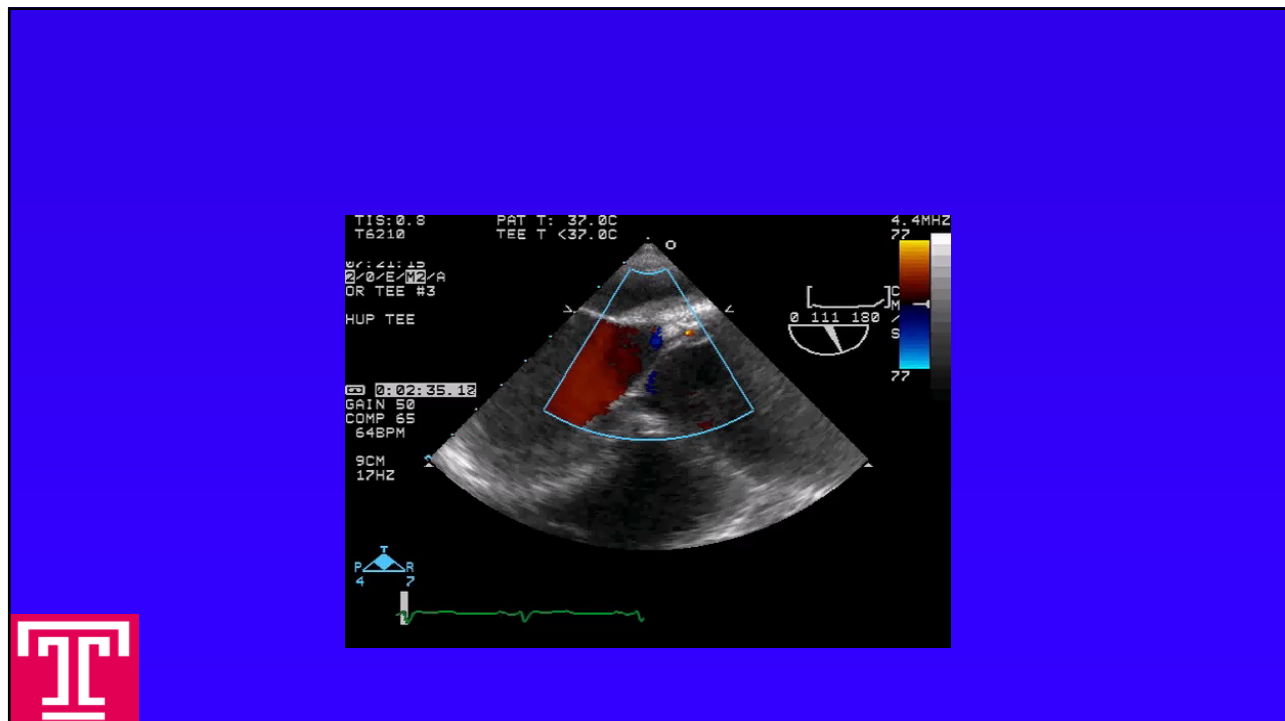
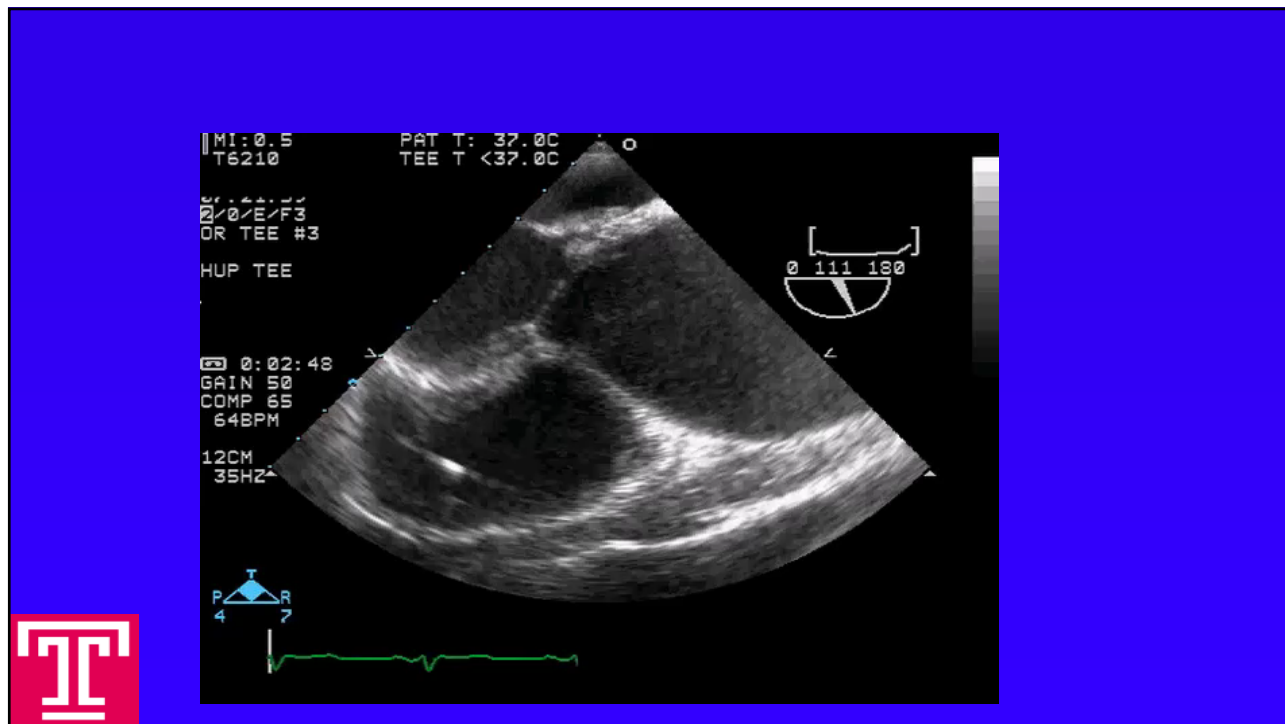
Sinotubular  
Junction  
enlargement  
and  
dilatation of  
the Asc AO

Dilatation of  
sinuses of  
Valsalva and  
sinotubular  
junction AO

Dilatation of  
the  
ventriculo-  
arterial  
junction

New Recommendations for Non-  
Invasive Evaluation of Native Valvular  
regurgitation



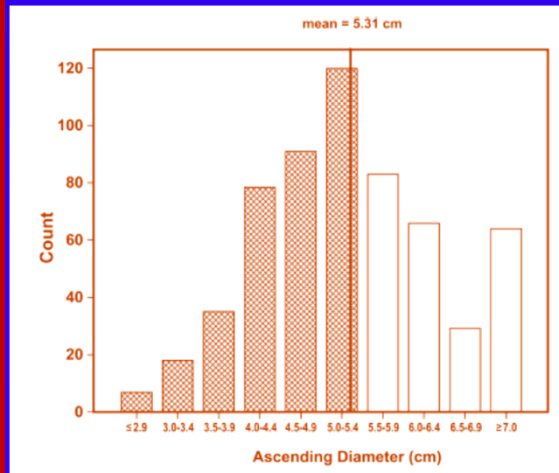


## Distribution of Aortic Size at the time of Presentation with Acute type A Dissection

Identification of patients at risk for dissection is difficult

- Hypertension
- Ao dilatation and aneurysm

Even pts with Marfans, Ehlers Danlos, familial aortic aneurysms, congenital bicuspid valve who are known to be at increased risk for dissection even go unrecognized until they present with acute aortic syndrome



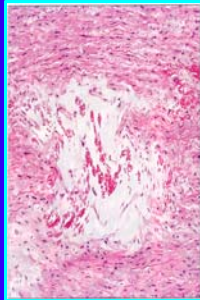
Identify patients with diameters <5.5 cm



## Identify the Reason for this Emergency TEE



## PATHOPHYSIOLOGY



- Deterioration of medial collagen and elastin



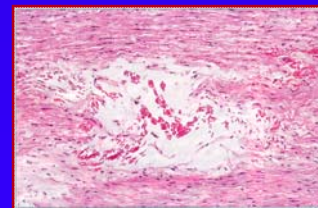
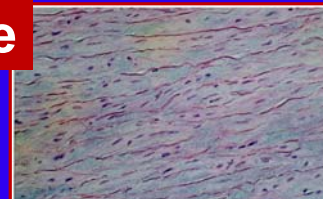
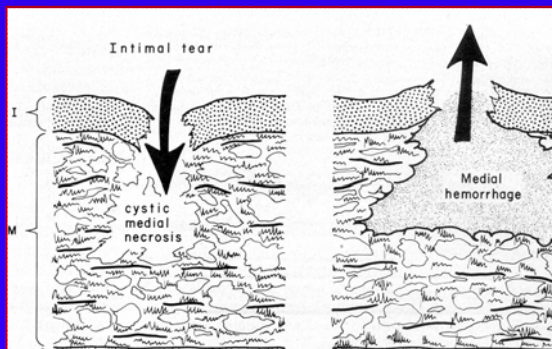
- A tear in the intimal layer allows blood to enter the intima-media space



- Blood then propagates down this new space creating a "true" and a "false" lumen



## Cystic Medial Change



- Hypertension
- Marfan's and Ehler-Danlos
- Coarctation and bicuspid aortic valve
- Pregnancy
- Trauma
- Perforation through an intimal atheromatous plaque



# PATHOPHYSIOLOGY

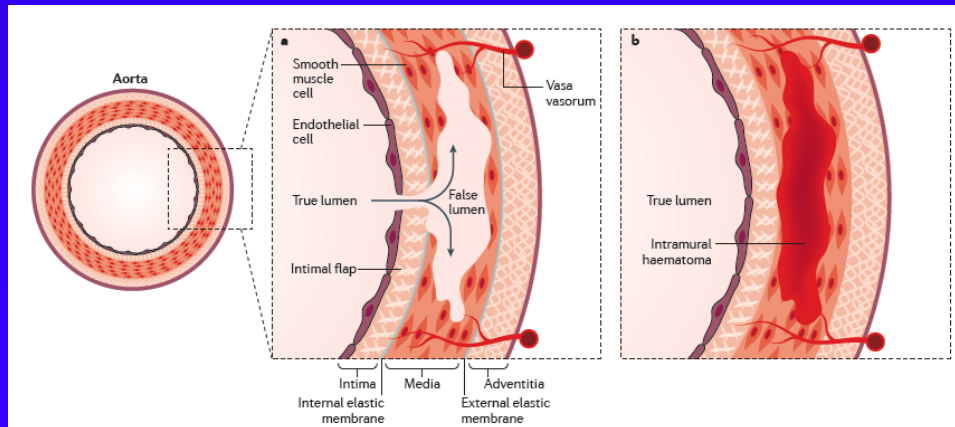
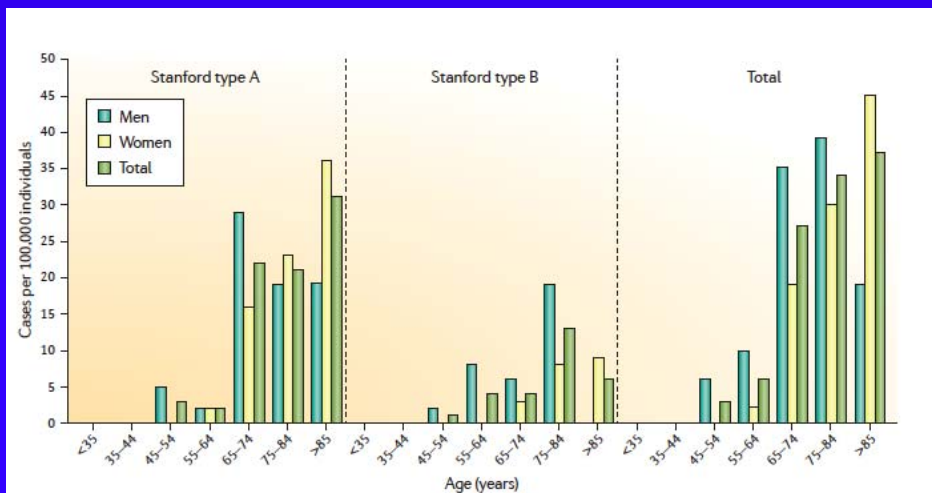


Figure 1 | Aortic dissection is caused by bleeding within the aortic wall. The aortic wall comprises three layers: the intima, the media and the adventitia. Bleeding within the medial layer forces the layers apart to form an intimal flap. a | Aortic dissection probably results from an intimal tear in

most cases. b | In some cases, aortic dissection may also be caused by rupture of the vasa vasorum (the capillaries that supply the aortic wall). This bleeding results in an intramural haematoma that may progress to form an aortic dissection.

## Age Specific and Sex Specific rates per 100,000 individuals for Incidence of acute aortic dissection subtype



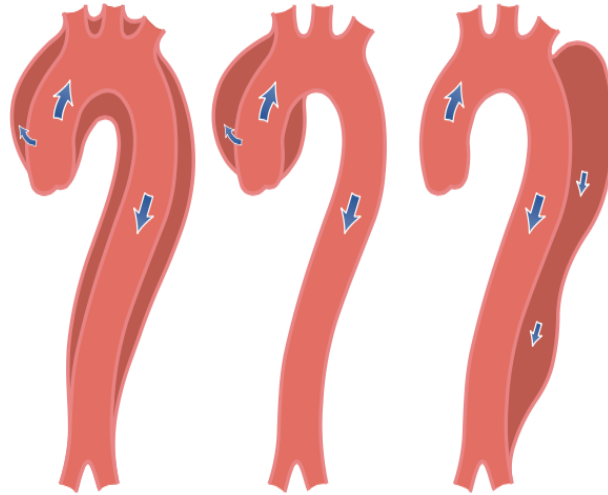
## Types of Aortic Dissection

De Bakey  
Stanford

Type I  
Type A

Type II  
Type A

Type III  
Type B

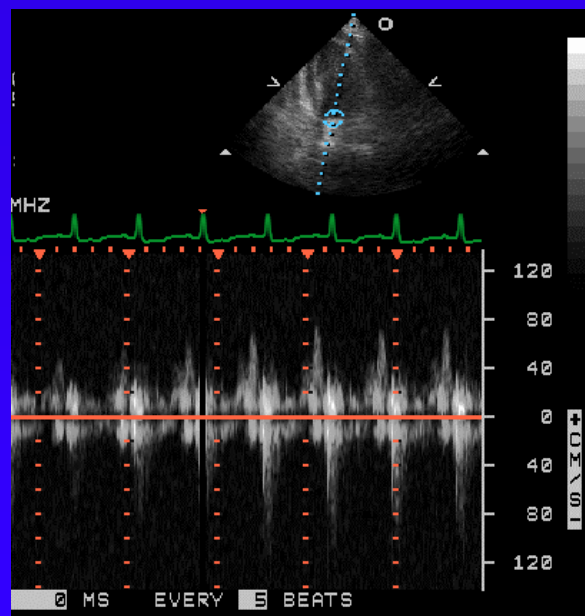
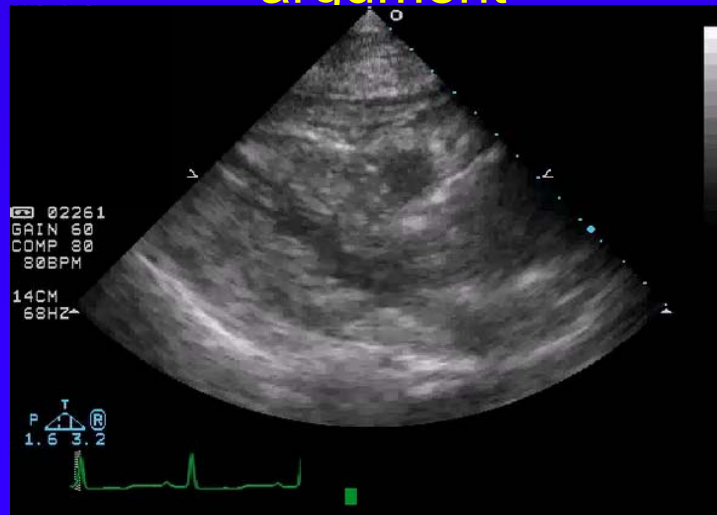


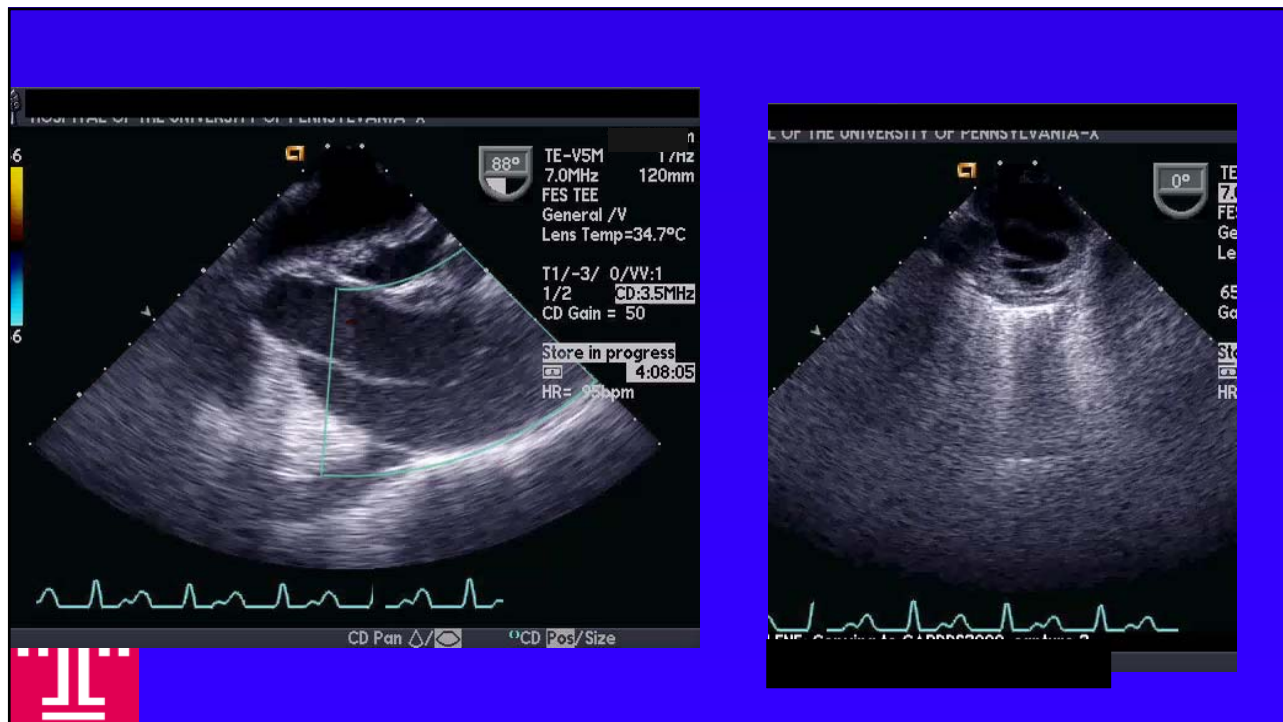
## Clinical Presentation: Physical Exam

	A + B	Type A	Type B	P =
AI on exam	32%	44%	12%	<.001
Pulse deficit	15%	19%	9.2%	.006
CVA	4.7%	6.1%	2.3%	.07
CHF	6.6%	8.8%	3.0%	.02



## 68 yo woman collapses during family argument





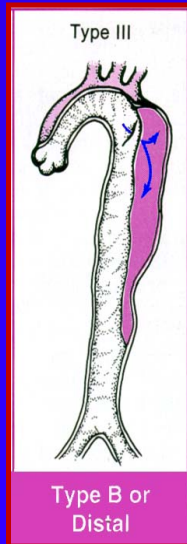
## Predicting Death in Patients with Acute Type A Aortic Dissection

- 547 pts; IRAD; Jan 96-Dec 99
- In hospital mortality 32.5%
  - Age  $\geq 70$  years
  - Abrupt onset of Cx pain
  - Hypotension, shock, tamponade
  - Kidney failure
  - Pulse deficit
  - ECG abnormalities



Circulation 2002;105:200-206

## Distal or descending – Type III Aortic Dissection

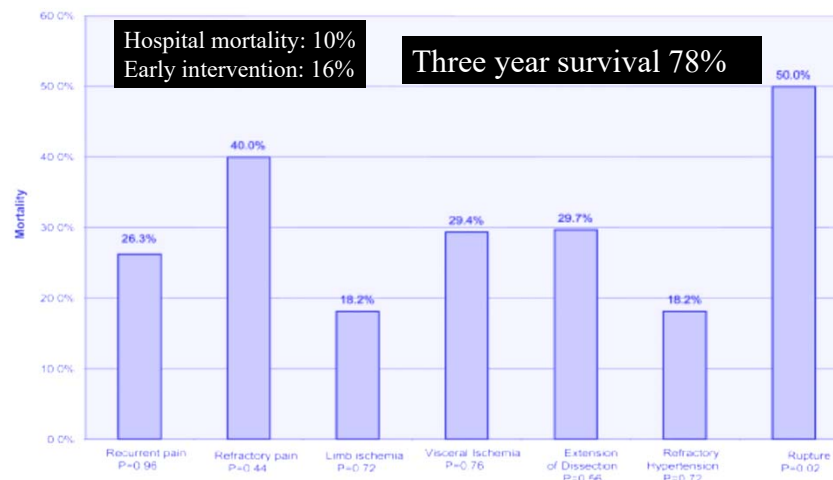


Iatrogenic (intra-arterial catheterization) – Type IV



## Incidence of Mortality in Type B Aortic Dissection With Different Indications for Surgical Treatment

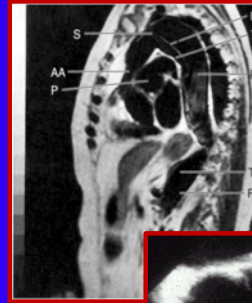
Surgery: rupture, aortic expansion, mal-perfusion and intractable pain



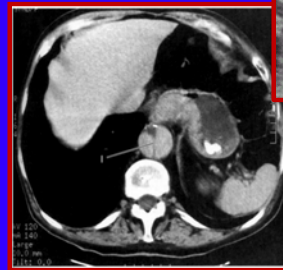
Circulation 2006; 114 (suppl I): I – 357-364

## GOALS OF DIAGNOSTIC IMAGING

- Confirm the diagnosis
- Classify the dissection and determine extent
- Detect extravasation
- Detect and Grade AI



- Aortography
- Spiral CT
- MRI
- TTE / TEE



## Aortic Dissection: Choice of Imaging Technique

- Fine tradeoff in sensitivity and specificity
- Availability of technique
- Experience and expertise at a given institution
- Degree of urgency
- Stability of the patient

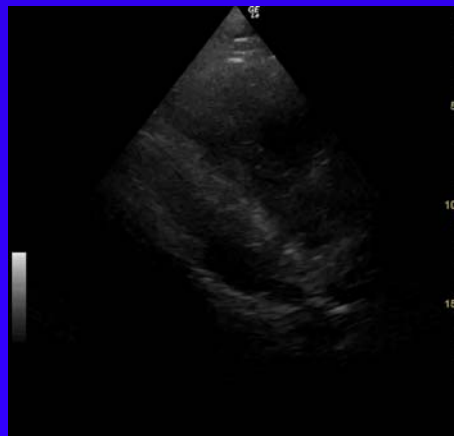


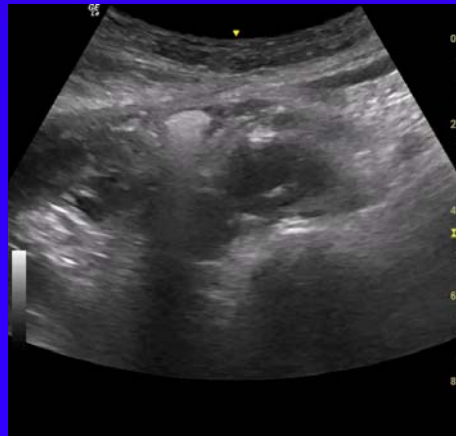
## Aortic Dissection: Why Multiple Studies?

- Initial study often done at referral site  
Confirmation needed or desired
- If CT first  
Still need cardiac anatomy, valve status etc
- If echocardiography first  
Still need assessment of abdominal aorta in many instances



## POCUS In ER – CVA – tachy on way to CT scanner





Leg pain - hypotension



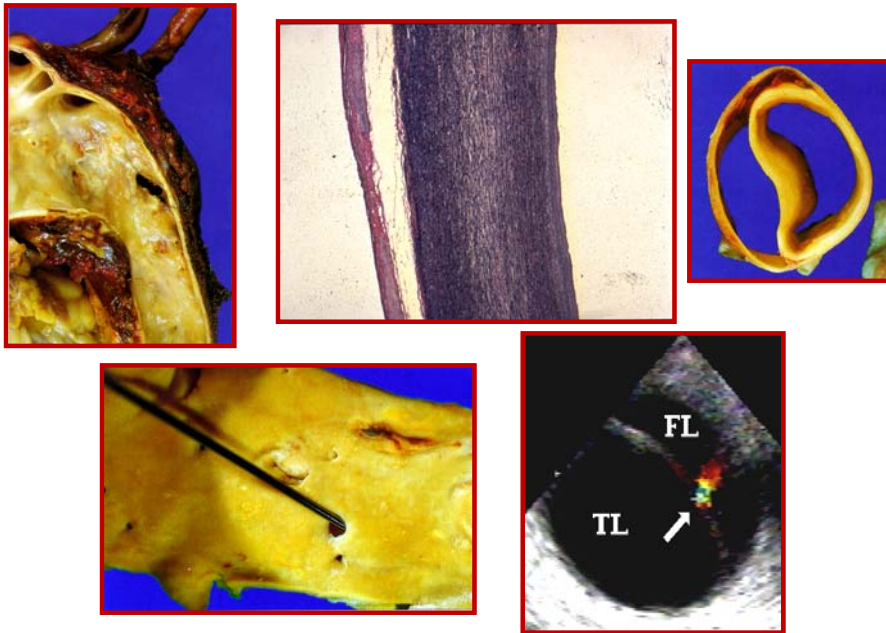


### Diagnostic value of different imaging modalities in acute aortic syndromes

Lesion	TTE	TEE	CT	MRI
Ascending aortic dissection	++	+++	+++	+++
Aortic arch dissection	+	+	+++	+++
Descending aortic dissection	+	+++	+++	+++
Size	++	+++	+++	+++
Mural thrombus	+	+++	+++	+++
Intramural hematoma	+	+++	+++	+++
Penetrating aortic ulcer	++	++	+++	+++
Involvement of aortic branches	+ <sup>2</sup>	(+)	+++	+++

<sup>2</sup>Can be improved when combined by vascular ultrasound (carotid, subclavian, vertebral, celiac, mesenteric, and renal arteries).  
 +++=excellent; ++=moderate; +=poor,(+)=poor and inconstant; CT=computed tomography; MRI=magnetic resonance imaging.  
 TOE=transesophageal echocardiography; TTE=transthoracic echocardiography.

## Aortic Dissection: Intimal Flap and Entry Site

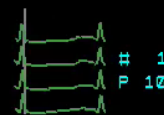


## 3D Epicardial Echo in Aortic Dissection

A/S/F3  
EHIRC  
DELHI  
Adult

0:34:10  
3D GAIN 50  
3D COMP 50  
86BPM

10CM  
25HZ



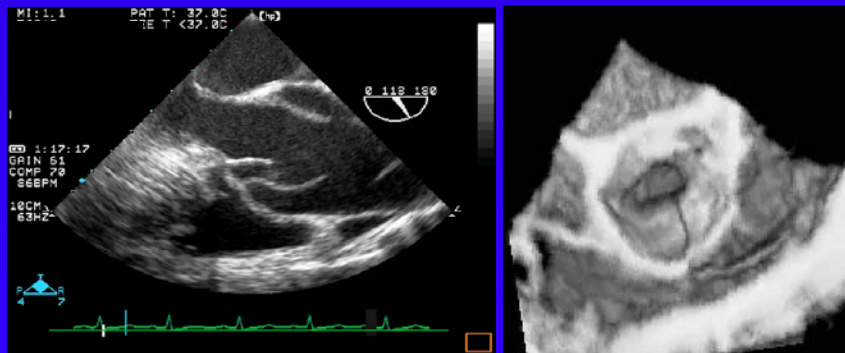


## TEE assessment

- Extent of flap
- Location of intimal tears
- Side branch evaluation - CORONARIES
- Pericardial effusion
- Mediastinal bleeding
- Aortic regurgitation and valve compromise

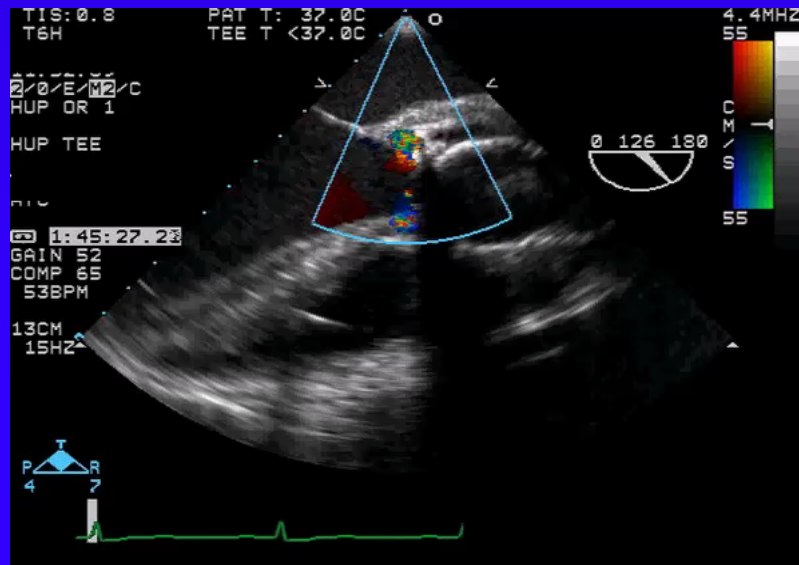


## Aortic Dissection: Mechanism of AR

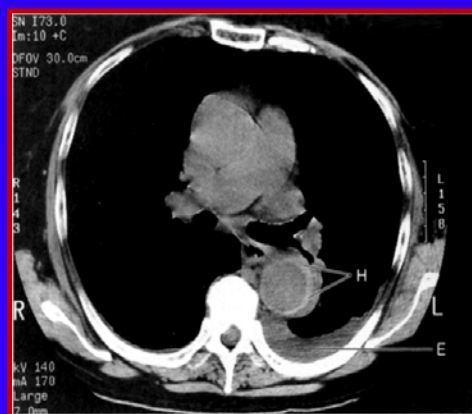


## Intimal Flap Prolapse

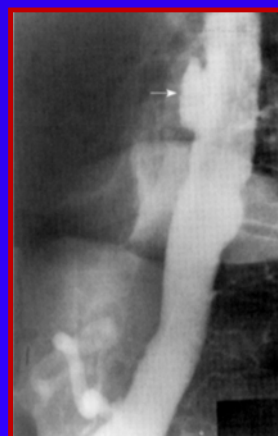
## Pseudoaneurysm



## Atypical Aortic Dissection



**Intramural  
Hematoma**



**Penetrating  
Atherosclerotic Ulcer**



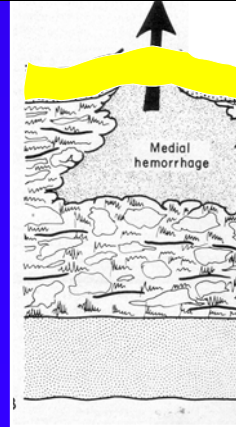
## Intramural Hematoma



- Rupture of the VASA vasorum

Discrete hematoma

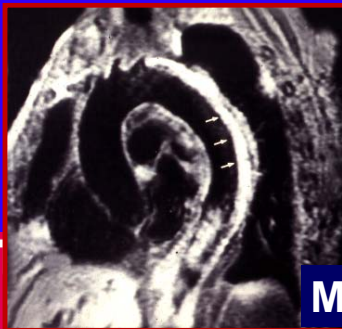
Extends for a variable distance by dissecting along the outer media beneath the adventitia



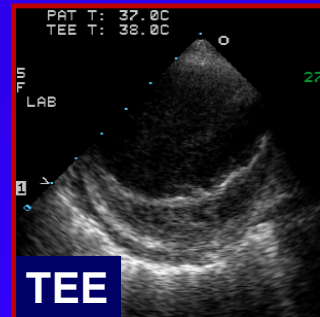
## Intramural Hematoma. Diagnosis



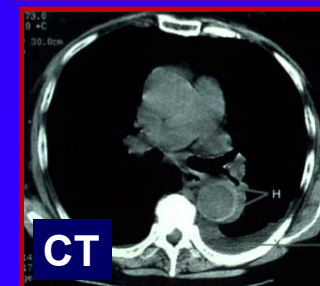
Contained hemorrhage within the medial layer of the aortic wall



MRI



TEE



CT

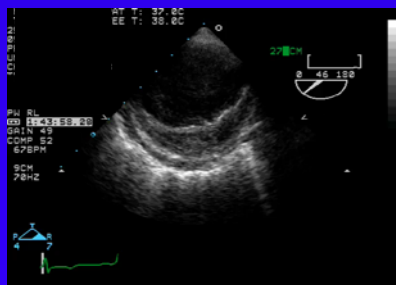


## Atypical Aortic Dissection (Intramural Hematoma)

- Prevalence 10-15% in CT/MRI/TEE studies
- Type III more common
- Normal size lumen
- False negative aortograms



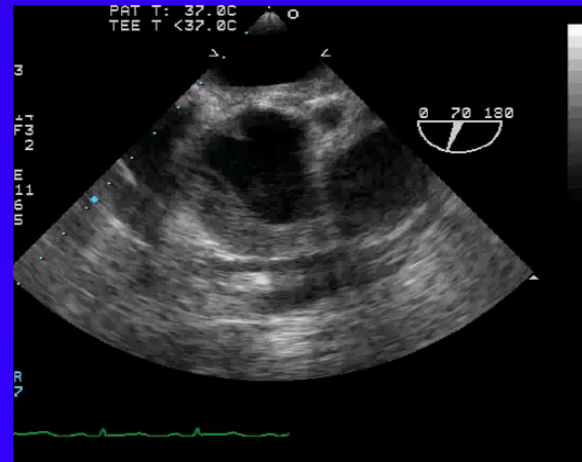
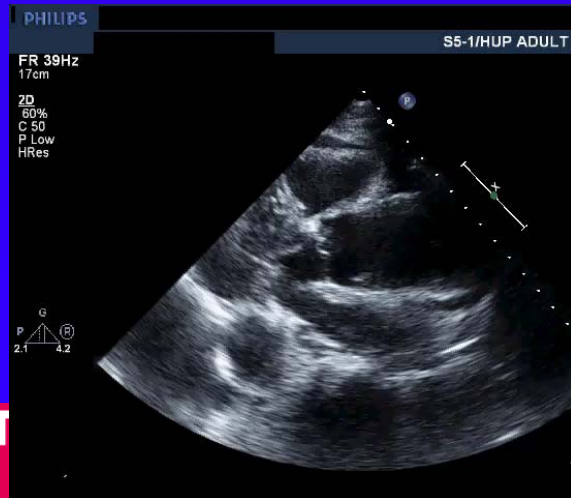
## Imaging features of IMH



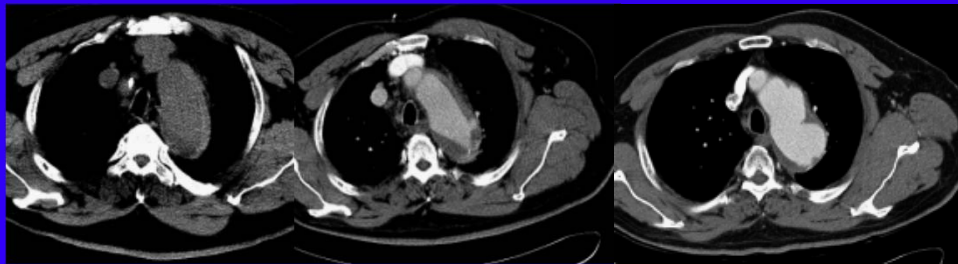
- Focal aortic wall thickening (crescentic > concentric)
- Preserved luminal shape with smooth luminal border
- Absence of dissection flap and false lumen
- Echolucent regions may be present in the aortic wall
- Central displacement of intimal calcium



## Intramural hematoma



## Acute and Chronic Complications of IMH



- Maximal thickness of the IMH ( $\geq 11\text{mm}$ ) predicts Ao dissection)
- Type A IMH and ulcer like projection should be monitored for the development of Ao aneurysm (common complication of IMH)



J Comput Assist Tomogr 2007; 31:435-440

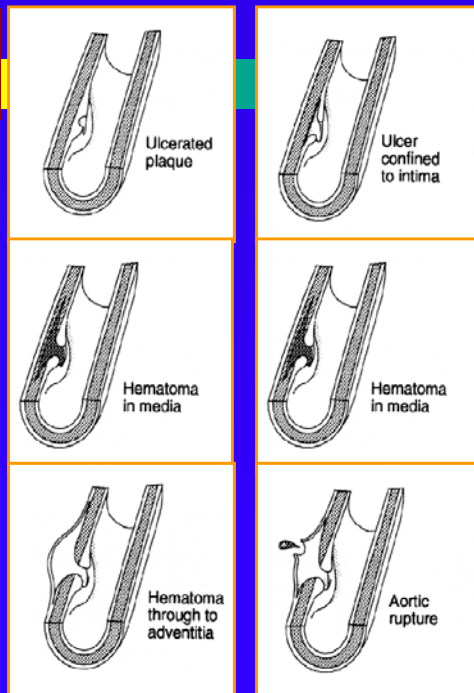
## Poor prognostic features

- Type A
- Persistent pain
- Wall thickness  $> 11$  mm
- Aortic diameter  $> 50$  mm or enlarging
- Penetrating ulcer or ulcer like projections
- Bleeding consistent with subacute rupture



### Penetrating Atherosclerotic Ulcer

- Almost exclusively in the descending Ao
- Usually remains localized
- Elderly HTN, evidence for other atherosclerotic CV disease
- Chest and back pain without associated AR or neurological deficits

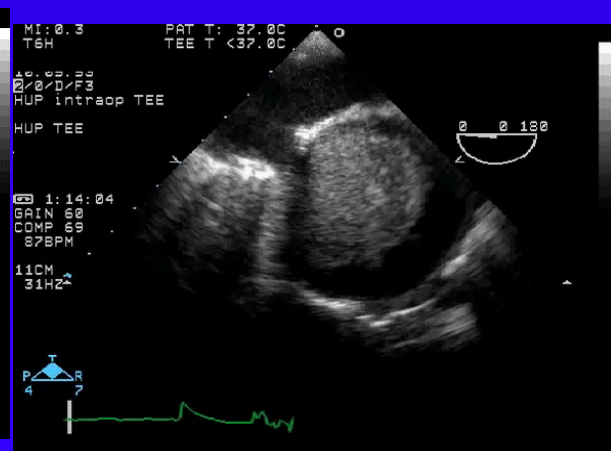
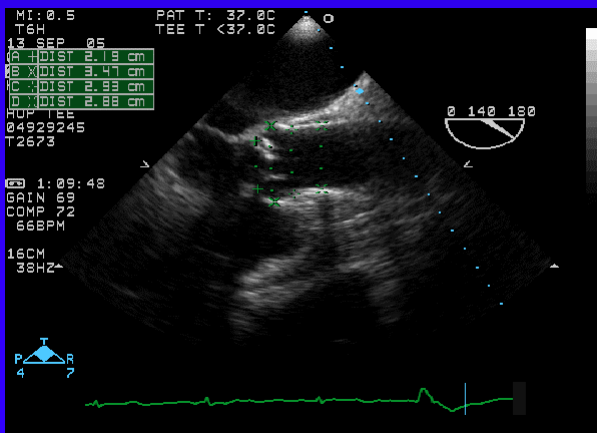


## Details required from imaging in Penetrating Aortic Ulcer

- Localization of the lesion (length and depth)
- Co-existence of intramural hematoma
- Involvement of the peri-aortic tissue and bleeding
- Thickness of the residual wall

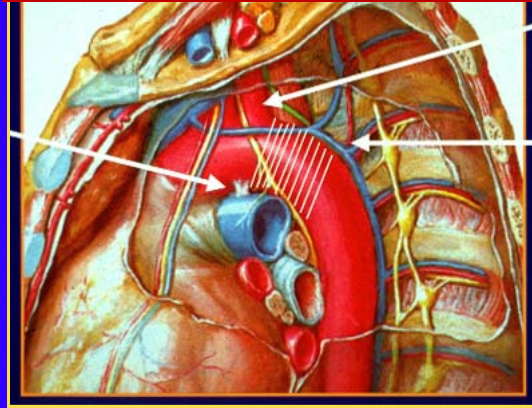


## Saccular arch aneurysm?

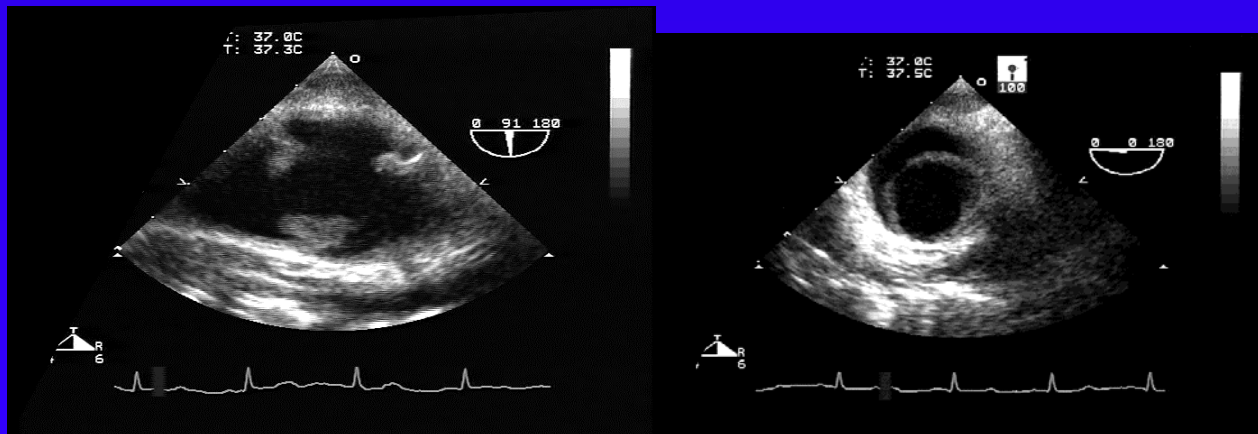




## Blunt Chest Trauma

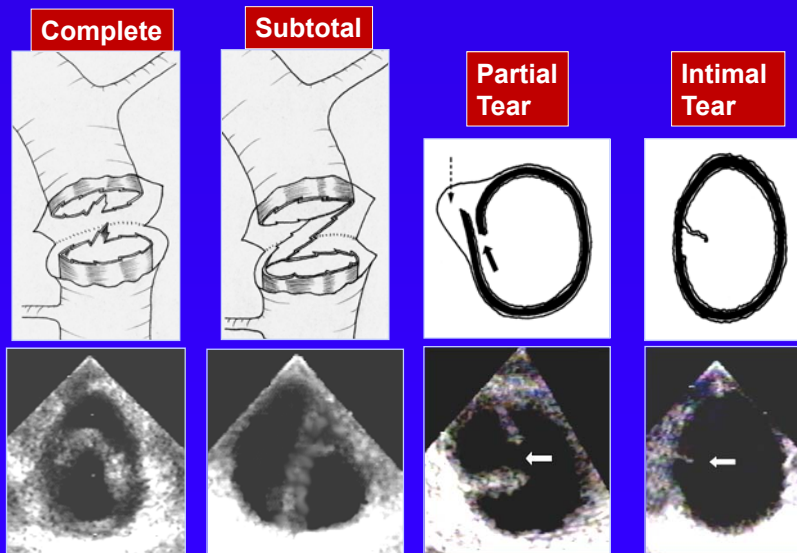


Generates shearing forces that act maximally on the aortic isthmus





## Aortic Disruption: Anatomical Types

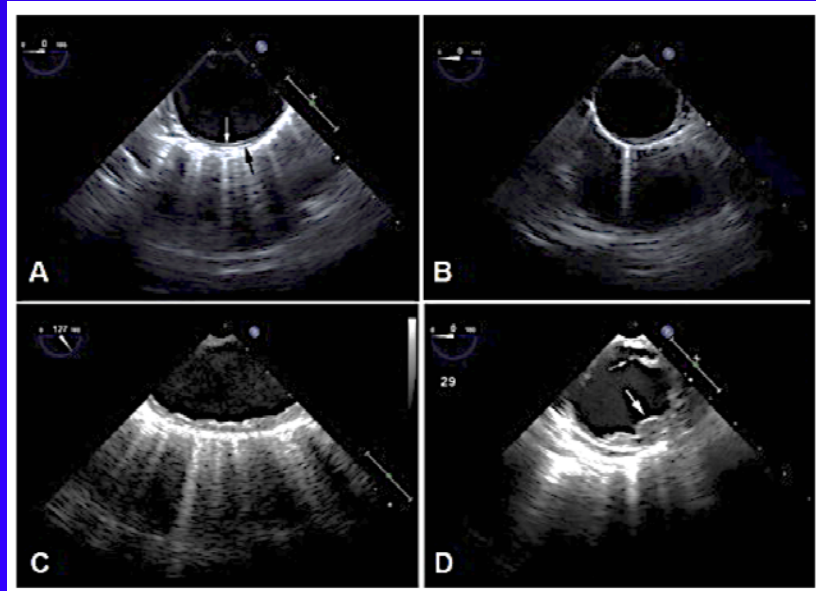


*Vignon et al. Circulation 1995;92: 2959-68*

## Grading system for severity of aortic atherosclerosis

Grade	Severity (atheroma thickness)	Description
1	Normal	Intimal thickness <2mm
2	Mild	Mild(focal or diffuse) intimal thickening of 2-3 mm
3	Moderate	Atheroma >3-5mm (no mobile/ulcerated components)
4	Severe	Atheroma >5mm (no mobile/ulcerated components)
5	Complex	Grade 2,3, or 4 atheroma plus mobile or ulcerated components

### Grading system for severity of aortic atherosclerosis



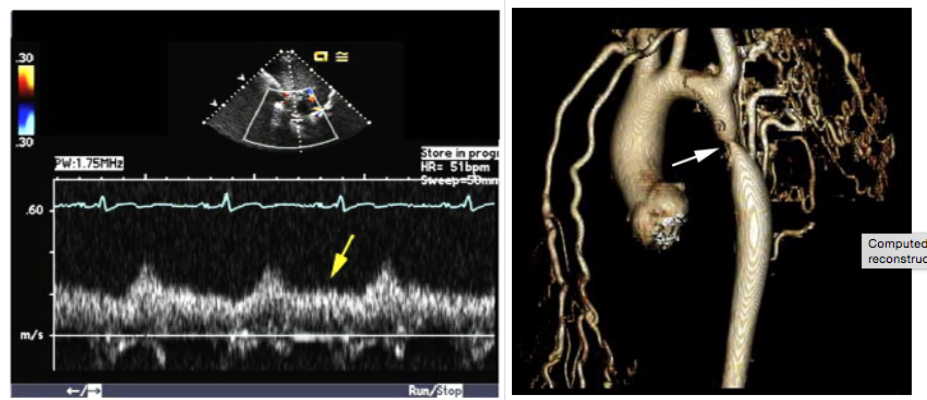
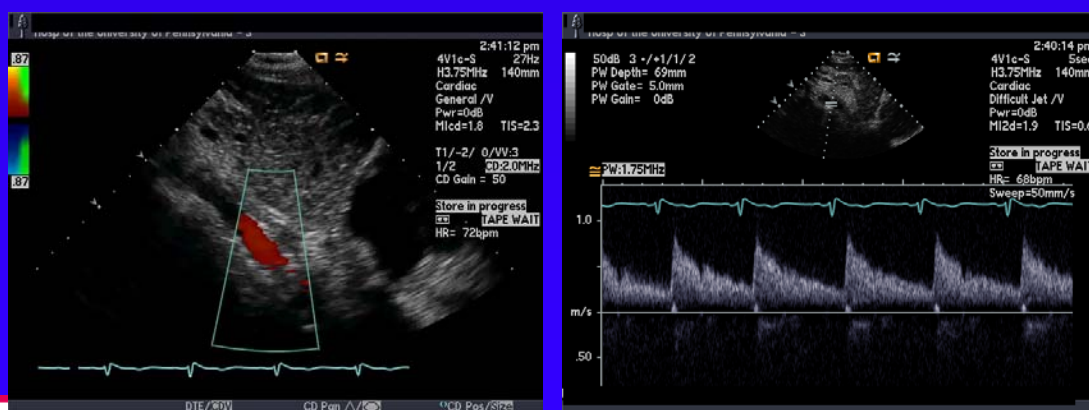


Figure 51.

Abdominal aortic pulsed-wave Doppler examination in a patient with severe aortic coarctation demonstrates reduced and delayed systolic forward flow and persistent forward flow during diastole (yellow arrow). This "diastolic tail" is a pathognomonic sign of a hemodynamically significant coarctation.



## Cardiovascular Ultrasound

- Don't forget to image the aorta
  - Parasternal long axis – ascending aorta view
  - Off axis 2 chamber – descending aorta view
  - Suprasternal notch – short axis and long axis
  - Subcoastal view – include assessment of aorta



Thank you for your attention  
GOOD LUCK WITH THE  
EXAM

